Closeout Report

on the

Department of Energy
Review Committee

on the

Technical, Cost, Schedule, and
Management Review

of the

TEVATRON RUN II LUMINOSITY UPGRADES

February 26, 2004

DOE F 1325.8
(08-93)

United States Government **Department of Energy**

memorandum

DATE: November 28, 2003

REPLY TO ATTN OF: SC-20

SUBJECT: Request to Conduct a Review of the Tevatron Run II Luminosity Upgrades

TO: Mr. Daniel Lehman, Director, Construction Management Support Division, SC-81

I would like to request that you conduct a review of the Tevatron Run II Luminosity Plan at Fermi National Accelerator Laboratory on February 24-26, 2004. The purpose of this review is to assess the performance of the Tevatron since the review in July 2003 and to evaluate the luminosity improvement plan for the Tevatron collider during fiscal years 2004-2006.

One of the conclusions of the July 2003, Department of Energy (DOE) review was that the Laboratory's plan was incomplete with the role of the recycler and electron cooling not fully detailed. The completed plan which will integrate the recycler into the Tevatron complex is scheduled to be delivered to DOE by the end of January 2004.

As part of a general assessment of the current status and evaluations for the luminosity improvement plan and the identification of potential issues, the committee should address the following specific items:

1. Is the laboratory plan reasonable to achieve the luminosity improvements projected in the completed plan?

2. Have adequate resources (i.e. manpower, funding, etc.) been identified and allocated to carry out the plan?

3. Is the proposed schedule credible and appropriate in light of the technical tasks required?

4. Has the lab developed an adequate risk analysis with identified fallback positions for the critical elements of the plan, such as electron cooling and the recycler?

5. Is the management structure appropriate for implementing the proposed plan to a successful completion?

6. The committee is also asked to assess the laboratory's response to the comments and recommendations form the July 2003 review.

Michael Procario is the program manager for Fermilab in this office and will serve as the OHEP contact person for the review.

We appreciate your assistance in this matter. As you know, these reviews plan an important role in our program. I look forward to receiving your Committee's formal report within 60 days of the review.

[signed]

Robin Staffin
Acting Director
Division of High Energy Physics

cc:
R. Orbach, SC-1
J. Decker, SC-2
L. Dever, SC-80
M. Procario, SC-221
A. Byon-Wagner, SC-223
M. Witherell, Fermilab
J. Monhart, FAO

Department of Energy Assessment of the Run II Luminosity Plan at the Fermilab Tevatron
February 24-26, 2004

Daniel R. Lehman, Chairman (DOE)

SC 1
Accelerator Physics

* Steve Peggs, BNL
Rick Baartman, TRIUMF
Francesco Ruggiero, CERN

SC 2
Proton Source

* Thomas Roser, BNL
Uli Weinands, SLAC
Karlheinz Schindl, CERN
[Rick Baartman, TRIUMF]

SC 3
Anti-Proton Source

* Flemming Pedersen, CERN
Fritz Caspers, CERN
Fritz Nolden, GSI
[Francesco Ruggiero, CERN]

SC 4
Tevatron

* Norbert Holtkamp, ORNL
Stuart Henderson, ORNL
Georg Hoffstaetter, Cornell
[Steve Peggs, BNL]

SC 5
Instrumentation

* Bob Siemann, SLAC
Massimo Placidi, LBNL

SC 6
Management and Systems Integration

* Jay Marx, LBNL
Klaus Berkner, Consultant
Marty Breidenbach, SLAC
Stephen Meador, DOE/SC

Observers

Robin Staffin, SC-20
Aesook Byon-Wagner, SC-20
Michael Procario, SC-20
Ronald Lutha, DOE/FAO
Jane Monhart, DOE/FAO

LEGEND

SC Subcommittee
* Chairperson
[ ] Part-time Subcom. Member

Count: 19 (excluding observers)

3/11/2004:q:sc-81:fermilab luminositiy:0307rev:revcomfrmilum.doc

Department of Energy Assessment of the
Run II Luminosity Plan at the Fermilab Tevatron

REPORT OUTLINE/WRITING ASSIGNMENTS

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     - 2.1.2 Comments
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   - 2.3 Anti-Proton Source [1, (2), (3), 4, 6].....Pedersen**/Subcommittee 3
   - 2.4 Tevatron [1, (2), (3), 4, 6]..... Holtkamp**/Subcommittee 4
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4. Schedule and Funding [2, 3, 6].....Meador**/Lutha
5. Management [1, 2, 5, 4, 6].....Marx**/Subcommittee 6

*[charge items to be addressed – parentheses indicate secondary importance]

**denotes lead

2.1 Accelerator Physics

S. Peggs (BNL), R. Baartman (TRIUMF), F. Ruggiero (CERN)

Findings

The recommendations from the previous review have (more or less) been addressed, sometimes in innovative ways not foreseen.

The new "Integration Department" consists of "Shot Analysis", "Accelerator Operations Co-ordination ", "Accelerator Physics", and "Rapid Response" teams.

Preliminary indications are that this re-organization is successful – or very successful

Accelerator Physics team is charged with maintaining the configuration data repository. Each system group head is mandated to certify these data. We applaud this approach.

Rapid Response team tackles specific problems on a medium timescale.

Its membership is dynamic, with dedicated manpower assigned to it on an "as needed" basis.

This approach has achieved impressive success on two recent activities - it appears to be very effective.

Extra attention given to the Booster has resulted in a factor of 3 reduction in beam loss activation for fixed proton throughput .

The "Finley report" for mitigating beam loss is being used to create a plan for the proton source upgrade.

However, must also place priority on studies to explore and understand intrinsic limitations on beam brightness.

Comments

Recommendation AP4 was somewhat misunderstood.

Develop a comprehensive model of the Collider complex, ...

The intent was to encourage development of a model that would answer questions such as:

"Would improved proton source brightness obviate the need for slip-stacking, and how would the resulting improvement in longitudinal brightness impact the rest of the chain?",

independent of previously agreed-upon Booster goals

The number of experts in impedance estimates, collective effects etc is smaller than the number of machines/departments in the Accelerator Division.

Therefore collective effects require some "intellectual mobility" and would ideally be dealt with at the level of the Integration Department.

The re-organization of Accelerator Physicists may lead to further short and medium term improvements in accelerator performance,

In the longer term it may weaken the capability to preserve and increase the overall Accelerator Physics resources and expertise at Fermilab.

The strong-strong beam-beam effect could limit the ultimate luminosity achievable at the Tevatron (see "Tevatron" comments).

Adequate beam physics studies time must be assigned to long term issues such as this, as well as to shorter term luminosity production issues.

Recommendations

1 Expand integrated modeling across the accelerator complex (from linac to collisions) to include collective effects, impedance budgets, emittance preservation, and intensity limitations, such as space charge effects in the Booster. Pursue an aggressive emittance reduction campaign with these tools, supporting the urgent investigation of cold anti-proton beam instabilities in the Recyler that might necessitate the use of a broad-band transverse damper.

2 Analyze baseline and luminosity scenarios, across multiple machines, under various fall back conditions, supported by a comprehensive model of the Collider complex.

Thomas Roser (BNL), Karlheinz Schindl (CERN), Uli Wienands (SLAC)

2.2 Proton Source

General Findings

The laboratory responded positively to most of the recommendations of the July 2003 review with the noted exception of recommendation 2 that requested a reexamination of the proton source capabilities and its benefit to the collider operation. A similar updated recommendation is made again.

In general the work on the proton source upgrade (WBS 26.1) is progressing according to schedule.

Comments

Good progress has been reported on a number of critical projects in the proton accelerator chain. However, after reports at the last review of very promising and successful initiatives to better understand the limitations especially in the Booster, we have been disappointed about the apparent stalling of this line of work. We would have liked to see more effort spent on understanding the limits on batch intensity and the causes for emittance growth, longitudinal and transverse, and on mitigating these limits and causes. There may be opportunities to further optimize luminosity performance for Run II.

Booster

The recommendation of the June 2003 Review concerning the supply crisis of TETRODE 7835 radio frequency power tubes for the five drift tube tanks of the Linac was addressed appropriately. A spare tube budget over the next few years has been established.

The implementation of a new four-magnet dog leg for Booster extraction, featuring smaller deflection angles, has largely eliminated the strong edge focusing which completely changed the dispersion and thus the horizontal acceptance. A new reoptimization allowed to cut beam losses at 4.5 e12/pulse (MiniBoone beam) by a factor 3 and to push the intensity limit beyond 5e12/pulse. The Committee congratulates the team for this remarkable success, not the least because of its beneficial effect on the proton beam brightness, decisive for Tevatron performance.

With the advent of MiniBoone and NUMI, the Booster becomes the workhorse of the complex and is likely to stay the beam intensity bottleneck. The beam loss must not exceed 400 W so as to enable hands-on maintenance. An improved two-stage collimation system was installed in fall 2003 and will be commissioned shortly. Realignment of the Booster, scheduled for the forthcoming shutdown, will help as well.

There are still beam losses at transition in the Booster that could be eliminated with the existing gamma-t jump system. Further work on orbit correction and magnet alignment will be needed.

Comments

The spectacular success of cleaning up the optics error in the Booster caused by the four-magnet dogleg highlights the importance of experienced machine physicists addressing long-standing, unsolved beam dynamics issues. Is the Booster now working at its absolute limit or can it be pushed further? In view of its impacts of the Tevatron performance, the Committee does not understand why these efforts are not vigorously pursued.

MiniBoone and NUMI, together with operation of the Tevatron, will lead to a fourfold increase of the proton throughput in the Booster. The Committee is confident that the two-stage collimation system will help managing the additional beam losses.

The recent beam dynamics work proved also beneficial for the collider beams (pbar production and protons for the Tevatron). These bright beams are generated in the Booster, therefore including Linac and Booster beam characteristics is a necessity to correctly assess overall performance.

Ionization profile monitors installed in the Booster are supposed to measure transverse beam emittances throughout the cycle. However, profiles are strongly distorted at high beam intensity. Obtaining reliable beam emittance information throughout the Booster cycle is important for improving beam brightness.

Regular monitoring of emittances along the injector chain starts only at MI injection. In order to improve the understanding of what happens in the Tevatron complex, Linac and Booster data need to be included in the emittance budget.

Between Linac and Booster output energies, the transverse emittances grow by more than a factor of 2. There are no beam profile monitor data showing when and how the blowup occurs, which are required for understanding beam dynamics effects (space charge, stop-bands) that drive it.

Main injector

At present the Main Injector (MI) does not constitute a performance limit, consequently there was not as much emphasis on the MI as at the last two reviews.

Longitudinal dampers have been installed and partially commissioned. The beneficial effect has been immediate by relieving the Booster from having to increase its longitudinal emittance, thus producing shorter bunches in the MI and the Tevatron. We commend the group for this success and suggest speedy completion of the commissioning.

Upgrade projects are in place for beam-position monitors to replace aging electronics and add functionality, and for the beam-loss monitors to allow readings of integral data for more monitors in any given cycle.

Work on the 2.5 MHz rf system necessary for capturing and accelerating pbars from the Recycler has progressed well.

Comments

The diagnostics upgrades for the MI are well motivated, but the time scale appears somewhat more long-term, limiting the benefits for Run II. The group is encouraged to unify the effort across machines, esp. MI and the Tevatron.

The reduced longitudinal emittance as a result of the longitudinal dampers is very encouraging. However, the bunch length is a prime factor in the pbar stacking rate and as such deserves significant attention. The importance of reducing the bunch length as far as possible does not appear to be fully recognized. We encourage the group to investigate means to further reduce bunch length; this includes alternatives to slip-stacking.

The momentum spread of 0.07% of the beam from the MI is causing problems in the Tevatron. MI and Tevatron groups are encouraged to get together and resolve this.

For 2.5 MHz operation, the phase control of the rf cavities to be used to manipulate the 53-MHz rf voltage when recapturing the beam will be challenging under high-beam-loading conditions. Beam-study time need is anticipated in July and the Committee suggests this request be given appropriate priority to ensure these important studies will be carried out in a timely matter.

Slip stacking

Good progress has been accomplished in the development of the slip-stacking technique of combining two proton batches from the Booster in the Main Injector. A maximum intensity of about 6e12 protons was reached. With beam loading compensation and after proper voltage matching the longitudinal emittance after slip-stacking two 0.1 eVs bunches was measured to be 0.3 eVs. It is expected that after acceleration and bunch rotation this will result in proton bunches with a full width of less than 1.5 ns.

The higher bunch intensity after slip-stacking will lead to significant beam loading of the 53 MHz rf system causing longitudinal emittance growth. A test of beam loading compensation on a single rf station was successful and the full complement of additional rf amplifiers has been ordered and should be delivered for installation in time for testing before the next major shut-down.

Making slip-stacking operational also awaits the implementation of reproducible cogging between the Booster and the Main Injector during the transfer of the second batch.

Comments

Slip-stacking two Booster batches in the MI has the potential of doubling the proton intensity on the pbar production target. However, the longitudinal emittance necessarily also at least doubles leading to longer bunches and thus increased pbar momentum spread after bunch rotation. To maintain the advantage of slip-stacking great care has to be given to keeping longitudinal emittance growth to a minimum. The MI longitudinal damper and beam loading compensation are the main tools to achieve this goal and adequate study time should be scheduled for testing and commissioning.

The lack of reproducible cogging between Booster and Main Injector presently prevents slip-stacking from being used for operation. This should be implemented as soon as possible. The beam intensity achieved with slip-stacking exceeds the present intensity used for pbar production. It might therefore already be useful for operation and this should be tested as soon as possible.

2.2.3 Recommendations

1. Determine the zero-stack pbar stacking rate using slip stacking including cogging necessary for multi-batch transfers and beam-loading compensation by May 2004.

2. Make short proton bunches for pbar production a priority.

3. Develop an aggressive plan for machine studies to increase beam intensity and brightness in the Booster beyond its present state by May 2004. This plan should include making the gamma transition jump operational.

4. Provide emittance measurements in the Booster throughout the cycle and include Linac and Booster beam characteristics into the performance overview of the Tevatron complex by May1, 2004.

2.3 Antiproton Source and Recycler

Sub-committee members:
Fritz Caspers, CERN
Fritz Nolden, GSI
Flemming Pedersen, CERN (chair)

Charge items 1,4, 5: Reasonableness of the plan, technical risks, reliability issues:

- General:
  - Much good work and progress done, particular the critical and challenging Recycler and electron cooling projects
  - Anticipated/planned increase in stacking rate has not yet materialized
  - FNAL has responded well to most of the recommendations of the previous DOE review

Antiproton Source and Recycler

Targeting, lithium lens upgrades:

- Re-designed lithium lens tests look promising: good chance of lifetime and/or gradient improvements

- Target beam sweeping: priority reduced, may not be needed, good insurance policy against target damage if needed with slip-stacking in MI

Antiproton Source and Recycler

- Debuncher, AP-2 aperture improvements:
  - Detailed plan presented, apertures and beam envelopes available in tabular form
  - Aperture restrictions identified from drawings and documentation, remedies planned over next 3 years
  - Beam based semi-automatic experimental procedures to identify location of aperture restrictions being developed but not yet working, more study time urgently needed.
  - Aim (HxV): 35 x 35 pi, actual 28 x 20 pi, expected 35x30 pi. Urgent to demonstrate experimentally the cause (optics? steering/alignment? dynamic aperture?)
  - Numerous improvements to correctors (jacks, trims) and diagnostics (BPM). Time to use them and profit from them!! More beam study time!

Antiproton Source and Recycler

- Debuncher, AP-2 aperture improvements:

  - Recommendation: Allocate pbar source study time in the order of 6 hours every second store to implement beam based alignment and obstacle finding procedures and reduce the discrepancy between expected and measured acceptances

  - Recommendation: Continue instrumentation upgrades, in particular improvements to AP2 BMP to enable BPM response matrix measurements with reverse protons in AP2.

Antiproton Source and Recycler

- Debuncher longitudinal cooling:
  - The energy spread of the beam injected into the Accumulator is a key performance parameter for the stacking rate: put the MI longitudinal damper into operation asap: 1.5 ns -> 0.6 ns bunch length
  - If same E_L conservation can be maintained for slip-stacked production beam we may hope for ~1 ns bunch length.
  - Recommendation: try slip-stacking as soon as possible: by May 2004
  - The anticipated improvement in BAW notch filter equalisers did not succeed. Crash program to change to optical notch filters looks very promising: factor 3 in notch quality!! To be installed in a few weeks.
  - η modulation in Debuncher being studied with low priority, decision in June.

Antiproton Source and Recycler

- Accumulator stack tail cooling upgrade:
  - The Committee concurs with the overall philosophy adopted for the stack tail improvements, i.e., effectively trading storage capability for flux capability, when the storage requirements can be shifted to the Recycler.
  - Recommendation: continue efforts to better understand and suppress effects which currently limit stacktail cooling performance. Impacts of further reduction of Debuncher momentum spread below the current design value of 6 MeV. Important fallback scenario if Recycler with electron cooling fails.

Antiproton Source and Recycler

- Rapid antiproton transfers:
  - The Committee did not identify any major issues here, and generally felt that there was a good chance that this effort would be largely successful.
  - Common 8 GeV energy definition to be implemented soon across complex, Recycler is reference, RF phase jump needed to cope with circumference errors, tested and works.

Antiproton Source and Recycler

- Recycler storage ring and electron cooling
  - Successful bake-out of complete Recycler ring during fall 2003
  - Recycler readiness performance milestones presented, impressive progress in commissioning since fall shut-down
  - Stacking and un-stacking scenarios for operation with Accumulator and Tevatron presented
  - EC test stand: design electron current obtained in test stand (0.5A), nominal gradient (V = 3.5 MV).
  - Successful recirculation of this current in cooling section in test stand, further improvements in beam quality still needed
  - Detailed commissioning plan for Recycler with electron cooler still missing

Antiproton Source and Recycler

- Recycler storage ring and electron cooling
  - . Detailed design and performance requirements of transverse damper for resistive wall instabilities missing and urgently needed: required spring 2005!!
  - The committee recommends installation of further BPMs in the electron cooling return line in case of recirculation problems in the Main Injector tunnel

Antiproton Source and Recycler

Charge items 2,3: Are there adequate resources, is schedule credible and appropriate?

- AP2 and Debuncher Acceptance: The scope of this work is better defined at this point: drawing research complete. There may be surprises until better agreement between measured and expected acceptances has been achieved experimentally
- Recommendation: Allocate sufficient scientific manpower to pbar source studies to establish confidence in the acceptance increase project. Re-evaluate manpower situation in pbar source department
- The Committee is pleased about the level of scientific manpower resources applied to the Recycler commissioning, and to electron cooling. The progress in these areas is impressive, but these projects is still challenging and carries significant risk.

2.4 Tevatron N. Holtkamp (Chair), S. Henderson, S. Peggs

2.4.1 Findings

- **Operation of the Tevatron** ☺
  - Luminosity has gone up from 2.6 x 10^{31} $cm^{-2}sec^{-1}$ in spring '03 to 4.5 in summer '03 and now went beyond 6.0. → x4 away from "Design"
  - Stores went beyond 30h and more than 130h / week are operated for luminosity (up from ~ 70 in summer, which was a concern).
- **Alignment** ☺
  - Has been extremely successful and involved an enormous coordination effort.
  - Many other beamline devices were aligned too, only separators are missing.
- **Diagnostics**
  - Very aggressive plan for BPMs was presented.
  - Much more diagnostics in the pipeline at various stages of completion.

2.4.1 Findings

- **Beam Beam Effects**
  - This is the big unknown !!! There are many indications that BB limits performance already.
- **The Resources** ☺
  - Adequate support in manpower and M&S
- **The Project Plan for the Tevatron** ☺
  - Is adequate planning tool for the upgrades that are ongoing in the Tevatron. Is mainly used as planning tool though and not for progress tracking of subprojects.
  - Good review process for technical subprojects

2.4.2 Comments

- **Beam Study Time**
  - Large backlog of beam studies to be done.
  - Technical decisions pending performance studies (→Separators)
  - Beam Beam effects threaten the performance goals
  - Management needs to consciously distribute Luminosity time and beam study time.
- **Alignment, Acceptance and Aperture**
  - Alignment campaign should be finished up, last few components measured and aligned.
  - Documentation of present status and careful measurement of status quo (acceptance, dynamics aperture etc) is required to have baseline for the future.
  - A little unsatisfying to live with large distributed skew quad error.
- **Beam-Beam**
  - Aggressively pursue theoretical and experimental studies to prepare for higher intensities.

2.4.3 Recommendations

1. Provide sufficient time (at least two shifts per week on average) for beam studies and commissioning of new hardware.
2. Commission the transverse injection dampers within the next 3 months.
3. Reevaluate the resource loading of the RUN II upgrade plan and develop appropriate tracking tools to easily assess the status of each subproject.
4. Develop and carry-out a program of beam-based measurements and simulations to establish beam-separation requirements and helix design criteria for the Design parameters in Run II. Present results at the next review.
5. Pursue a vigorous investigation of beam-beam effects, including strong-strong beam-beam effects, to evaluate possible limitations on the ultimate Tevatron luminosity, and to evaluate possible amelioration. Present results at the next review.
6. Characterize the Tevatron aperture to quantify gains after alignment and optics improvements.
7. Finish up and document the alignment of the Tevatron.

The Movie

Instrumentation Sub-Committee
Massimo Placidi (LBNL), Bob Siemann (SLAC)

Selection of the Findings

- There is increased emphasis on and appreciation of the value of instrumentation.
- Major Beam Position Monitor (BPM) systems have common technology choices and a common approach.

- Tevatron - Installation of BPM system should be completed at end of October shutdown. It will have the capability to measure both protons and anti-protons at the same time. (This is a positive response to a recommendation made in July, 2003.)

- AP2 line – The BPM's cannot detect anti-protons but they can be used with reverse protons to tune and perform beam based alignment. However, kicker noise is still a problem for some BPM's.

- Booster - There are possible improvements and/or new techniques that could be applied to measure the emittance evolution during the acceleration ramp.

Comments

- The present emphasis on instrumentation is appropriate and will yield long term benefits.
- The instrumentation projects have had adequate resources identified and the schedules are credible and appropriate.
- Measurements of the Booster emittance during the ramp would give important data on the emittance evolution.
- The long delay before the MI BPM system is installed is not pleasing, but it is a reasonable priority decision.
- The realignment of the Tevatron elements proved very useful. The procedure should be repeated on yearly basis now that a grid has been established.
- A detailed plan to migrate controls to the modern computing hardware and software still needs to be developed.

Recommendations

1. Investigate the source of kicker noise in the AP2 line BPM's during the March shutdown and improve the AP2 line BPM system to work with reverse protons over its entire length by the end of the summer 2004 shutdown.

2. Perform a study of possible methods to measure the emittance evolution during the Booster ramp by May 1, 2004.

3. COST ESTIMATE (Steve Meador, Ron Lutha)

3.1 Findings

A revised cost estimate is included in the updated Run II Plan (v2.0). This new estimate reflects improved definition of existing scope and incorporation of new scope identified by a series of technical reviews coordinated and tracked by the Upgrades Project Office. Changes to the Plan were made using a newly established change control process. The estimate includes only the activities associated with the Upgrades Plan – estimates for operations' cost were not included in the Plan.

Overall, there was a relatively small increase to the Upgrades' total cost estimate, but costs for several individual WBS elements varied significantly. Contingency is included in the cost estimate (roughly 50% of the total cost). A comparison of the estimates supporting v1.0 and v2.0 of the Plan is included in Appendix __. A summary of the two cost estimates is provided below:

$K (in $FY03)	**v2.0**	**v1.0**
M&S Base estimate	16,461	14,965
M&S Contingency estimate	7,356	7,462
M&S Total	**23,817**	**22,427**
Labor Base estimate	17,980	18,194
Labor Contingency estimate	9,213	9,706
Labor Total	**27,193**	**27,900**
M&S+Labor Total	**51,010**	**50,327**

At the review the Committee was provided an updated WBS Dictionary and Basis of Estimate document that supports the new cost estimate and provides information on activity duration, labor categories and materials and supplies. Since the last review the WBS has been slightly modified to correspond to new cost accounting system codes established by the Laboratory.

3.2 Comments

The Upgrades' Project Office has addressed the recommendations

from the last review. The cost estimate will serve a cost "benchmark" against which progress and performance will be tracked. This process is described in the management procedures appended to the updated Plan.

The Committee did not conduct a detailed cost assessment, however, the estimates for the Upgrades activities and contingency are supported by well documented basis of estimates and overall appear reasonable.

3.3 Recommendations

1. Maintain the current level of rigor in developing and updating the cost estimate as the Project Office transitions to tracking and monitoring progress and performance against the cost benchmarks.

4. SCHEDULE AND FUNDING (Steve Meador, Ron Lutha)

4.1 Findings

The Upgrades' schedule has been developed in MS Project. The updated v2.0 schedule contains nearly twice the number of activities (1,360) in the schedule developed for v1.0 of the Plan. Activity start and finish dates are documented in the Basis of Estimate. Many of the scheduled activities are performed in parallel. Efforts are underway to identify critical paths associated with 5 key operating phases. A summary schedule is included in Appendix ___.

Approximately 80 milestones (between July 2003 and September 2007) have been developed that represent physical progress evaluation points, major scope decisions and planned internal technical reviews. The Project Office changed the definition of the milestone hierarchy to give visibility to milestones that drive the luminosity profile.

The funding profile for the Upgrades activities is shown in the table below.

In actual year $K	FY03	FY04	FY05	FY06	FY07	Total
M&S						
26 M&S Base	937	8,437	3,605	651	0	13,629
26 M&S Cont	0	2,531	2,524	607	0	5,662
26 M&S Total	**937**	**10,968**	**6,129**	**1,258**	**0**	**19,291**
27 M&S Base	258	1,383	739	1,083	0	3,463
27 M&S Cont	0	415	517	1,029	0	1,961
27 M&S Total	**258**	**1,797**	**1,257**	**2,112**	**0**	**5,424**
26&27 M&S Total	**1,195**	**9,819**	**4,344**	**1,734**	**0**	**17,092**
Base						
26&27 M&S Total	**1,195**	**12,765**	**7,386**	**3,370**	**0**	**24,715**
SWF						
26 SWF Base	3,569	8,102	3,553	2,012	454	17,690
26 SWF Cont	0	3,066	3,557	1,838	332	8,793
26 SWF Total	**3,569**	**11,168**	**7,110**	**3,849**	**786**	**26,483**
27 SWF Base	152	345	478	171	10	1,155
27 SWF Cont	0	138	502	171	7	818
27 SWF Total	**152**	**482**	**981**	**341**	**17**	**1,973**
26&27 SWF Total	**3,721**	**8,446**	**4,032**	**2,183**	**463**	**18,845**
Base						
26&27 SWF Total	**3,721**	**11,650**	**8,091**	**4,191**	**802**	**28,456**
Total	**4,916**	**24,415**	**15,476**	**7,561**	**802**	**53,171**

4.2 Comments

Again, similar to cost the Committee did not conduct a detailed schedule assessment, however, the timing, nature, number and sequence of milestones seem appropriate.

Plans to meet every two weeks with the Level 2 and 3 managers to status milestones and measure schedule progress will aid in improving the quality of the schedule and reinforcing the newly established management procedures.

4.3 Recommendations

None

5.0 Management Subcommittee

Jay Marx (chair), LBNL
Marty Breidenbach, SLAC
Klaus Berkner, LBNL (ret)
Steve Meador, DOE

Key Findings and Comments

1. **The successes of the past 7 months indicate the capabilities of the new management team to lead, organize and integrate the efforts of the Accelerator Division. The systematic approach taken to the complex has had a major impact and is an important platform for future success.**

2. **Morale, pride and discipline is on the upswing. Everyone seems to be pulling together. This is a product of success and is major achievement.**

3. **The Upgrade plan was revised and improved to include integration of the recycler and a number of schedule changes.**

4. **The management must develop procedures that utilize the upgrade plan as a basis to monitor, track and evaluate progress and resource usage against expectations. This is an important management function.**

5. **It appears that level of support and focus from the Laboratory Directorate and from other parts of the laboratory is at an appropriate level for successfully carrying out Run II activities (witness shutdown success). Adequate levels of resources (people and funds) are being provided to the Run II effort.**

6. **It is essential for the management to fully assess the staffing and resources needed to reach the luminosity goals. This includes operations, commissioning and maintenance activities. A comprehensive plan for the operations and maintenance components of Run II would assure that the right level and mix of staffing and other resources are identified and allow monitoring progress and tracking resource utilization against expected progress.**

7. **The Laboratory management should assess the resources (e.g. staffing, funding, proton economics) that would be needed to meets its other commitments, current and planned, and assure that these commitments are at a level that doesn't interfere with the Run II effort.**

8. **Management must assure that adequate beam time is devoted to studies that will enhance performance in the longer-term.**

Recommendations-

1. **By May 1, 2004 develop and implement procedures to utilize the upgrade plan as a basis to monitor and track and evaluate progress on the upgrades against expectations.**

2. **By June 1, 2004 produce a comprehensive plan addressing manpower needs and expected progress for the operations, commissioning and maintenance components of Run II.**

Review Summary

Great progress has been made since last review in July 2003.

Successful shutdown-accomplished goals

The Tevatron complex has never performed better

At last review we said ---
“Success requires the new management team to effective lead and integrate the many technically complex activities that make up Run II. The next 6 months will be critical.”

The successes of the past 7 months are indicative of the very hard work of high quality staff working on Run II and the capabilities of the management team to lead and organize the Division's efforts.

The Laboratory as a whole appears to be focusing on Run II and providing support at the level needed for success. This is important.

Luminosity Projections

The Laboratory has presented two projections of the luminosity through FY09, a "design" projection of 8.5 fb-1 and a "base" projection of 4.4 fb-1.

The "design" projection assumes timely success with the stack-tail cooling upgrade, antiproton stacking rates, beam-beam performance in the Tevatron and electron cooling in the recycler. Although very good progress has been made, there is still significant uncertainty.

The "base" projection could be reached without the stack-tail cooling upgrade or electron cooling if there is no schedule slip in other upgrade activities and if their performance goals are met.

Because of progress on Run II upgrade activities since the last review, the committee now views the base goal of 4.4 fb-1 by the end of FY09 as having a good probability of being met or even exceeded.

Meeting the design goal of 8.5 fb-1 by the end of FY09 remains a very challenging goal.

The Plan

The Laboratory correctly characterizes Run II as a "complex campaign of operations, maintenance, upgrades, R&D and studies."

Planning must be considered in this context The revised plan for the upgrades is a solid foundation

The team must now use the plan as a basis to monitor and track and evaluate resource usage and progress compared to expectations.

And planning and tracking for the operations, commissioning and maintenance components is essential.

So what's the bottom line?

We're very impressed with the progress in the past seven months.

We have increasing confidence that Run II will be successful.

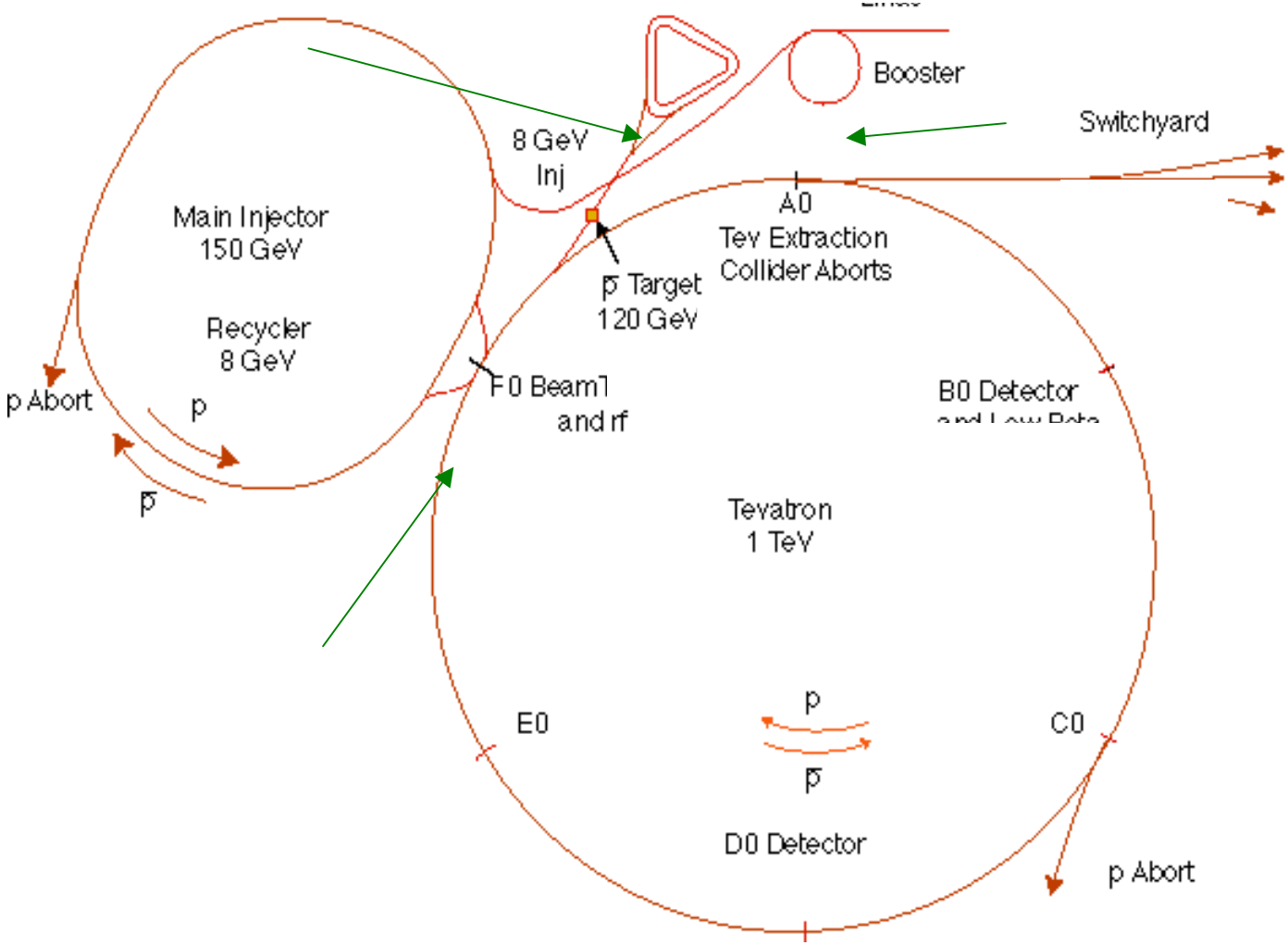
We look forward to continued progress toward the Tevatron complex being reliable, and well-characterized to serve as a platform for the cutting edge upgrades.

But there's a long way to go in the complex campaign of operations, maintenance, upgrades, R&D and studies that must succeed if the luminosity goals are to be reached.

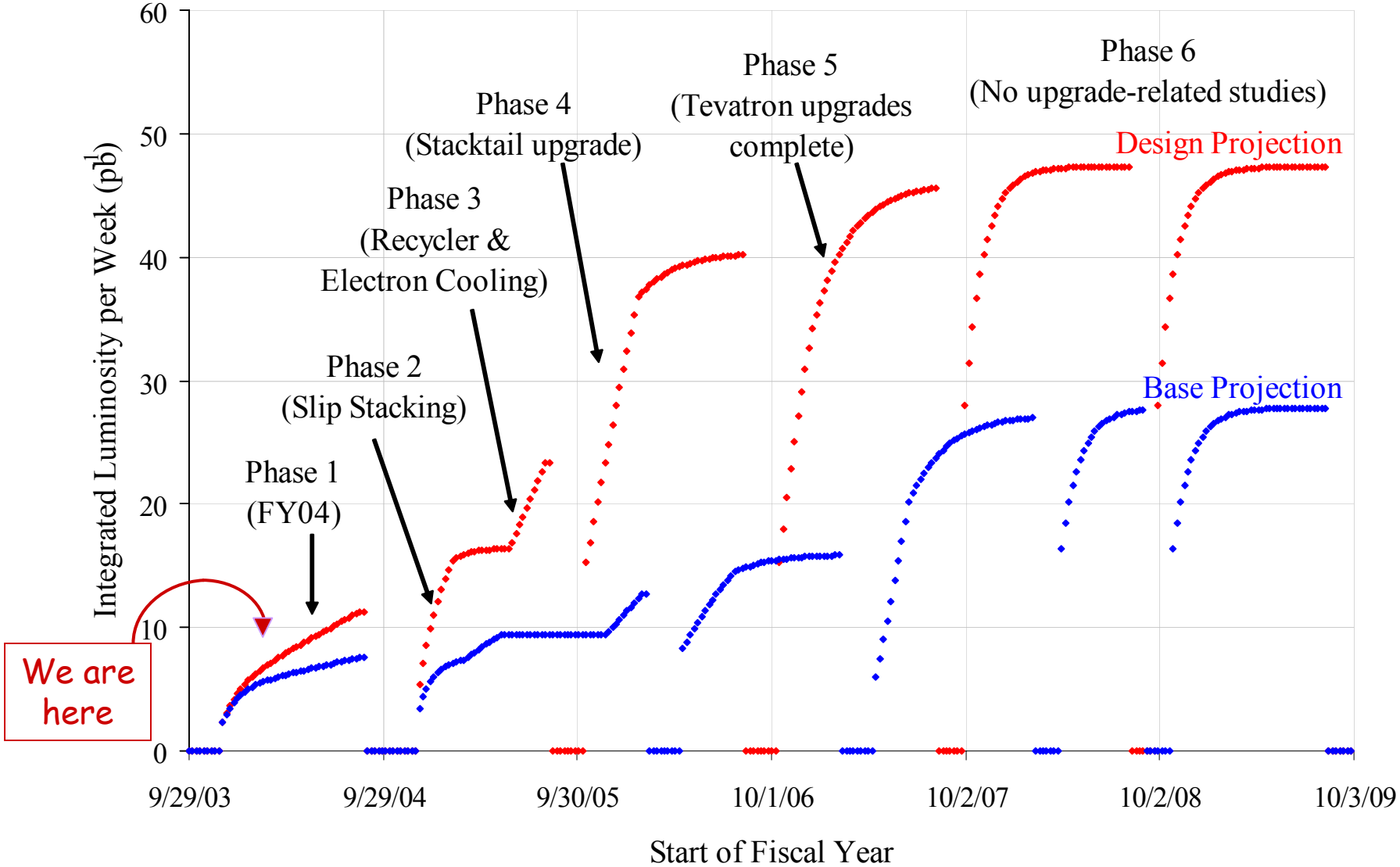
We see a significant challenge in the installation and successful commissioning of electron cooling in the next 16 months

Keep up the discipline, focus, dedication and good work. We are very encouraged!!!

FermilabTevatron Accelerator With Main Injector



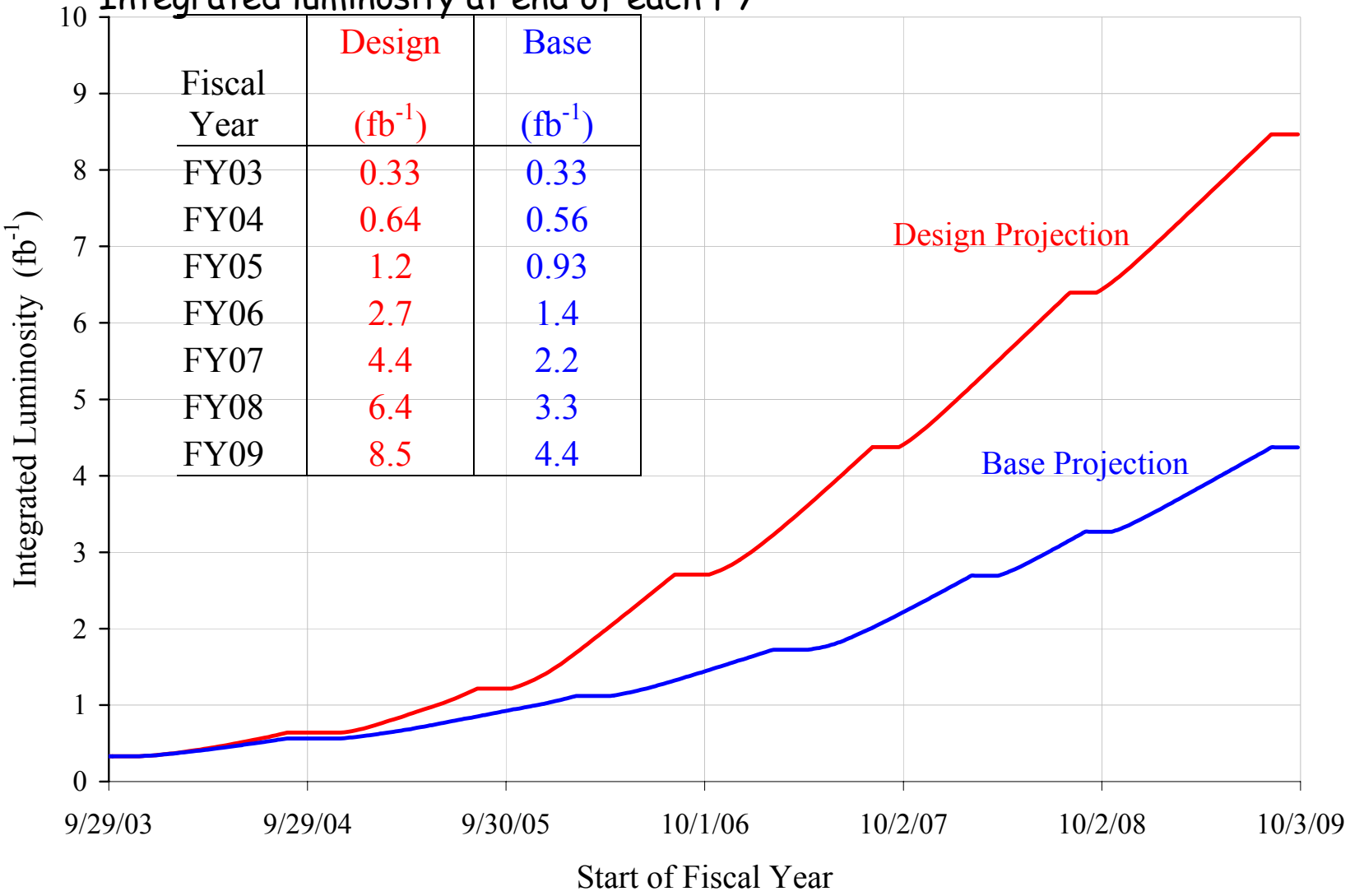
Design and Base Projections



Design and Base Projections

Integrated luminosity at end of each FY

Fiscal Year	Design (fb^{-1})	Base (fb^{-1})
FY03	0.33	0.33
FY04	0.64	0.56
FY05	1.2	0.93
FY06	2.7	1.4
FY07	4.4	2.2
FY08	6.4	3.3
FY09	8.5	4.4



Department of Energy Assessment of the
Run II Luminosity Plan at the Fermilab Tevatron

AGENDA

Tuesday, February 24, 2004

8:00 am	**Committee Executive Session—Comitium ..... Lehman**		
9:00 am	Welcome and Opening Remarks—**1 West** ..... Witherell		
9:05 am	Introduction ..... Holmes		
9:15 am	Accelerator Division Organization and Management Issues ..... Dixon		
9:55 am	Tevatron Run II Status and FY04 Plan ..... McGinnis		
10:45 am	Break		
11:00 am	Tevatron Run II Plan, Rev 2.0 (Cost, Schedule, Milestones, Contingency) .. Spalding/Bhat		
12:00 pm	Lunch		
1:00 pm	Recycler Status and Commissioning Plan ..... Nagaitsev		
1:30 pm	Protons on Target ..... Kourbanis		
1:50 pm	Antiproton Production ..... Werkema		
2:10 pm	Antiproton Stacking and Cooling ..... Derwent		
2:35 pm	Break		
2:50 pm	Tevatron ..... Shiltsev		
3:20 pm	Reliability and Maintenance Upgrade Status ..... Czarapata		
3:45 pm	**Breakout Sessions**		
	Management and Systems Integration	SC 6	Room 1 North
	Protons	SC 2, 5	Room Race Track (7th)
	Antiprotons (Production, Stacking, and Cooling)	SC 3, 5	Room 12NE
	Tevatron	SC 4, 5	Room 9SE
	Accelerator	SC 1	Room TBD
4:45 pm	**Subcommittee Executive Sessions—Rooms same as above**		
5:00 pm	**Full Committee Executive Session—Comitium**		

Wednesday, February 25, 2004

8:00 am	**Breakout Sessions**		
	Management and Systems Integration	SC 6	Room 1 North
	Protons	SC 2, 5	Room Race Track (7th)
	Antiprotons	SC 3, 5	Room 9SE
	Tevatron	SC 4, 5	Room 1 East
	Accelerator	SC 1	Room TBD
12:00 pm	Lunch		
1:00 pm	**Breakout Sessions Continued**		
2:00 pm	**Subcommittee Executive Sessions**		
3:00 pm	**Full Committee Executive Session—Comitium**		

Thursday, February 26, 2004

10:00 am	**Full Committee Closeout Dry Run—Comitium**
12:00 pm	Lunch
2:00 pm	**Review Closeout Presentation—1-West**
3:00 pm	**Adjourn**

SC Subcommittee

ACTION ITEMS

Resulting form the February 24-26, 2004
Department of Energy Assessment of the
Run II Luminosity Plan at the Fermilab Tevatron

Action	Responsibility	Due Date
1. Conduct mini-review	DOE/Fermilab	September 8, 2004
2. Conduct status review	DOE/Fermilab	February 2005

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